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(54) **AIR DRAG REDUCTION SYSTEM**

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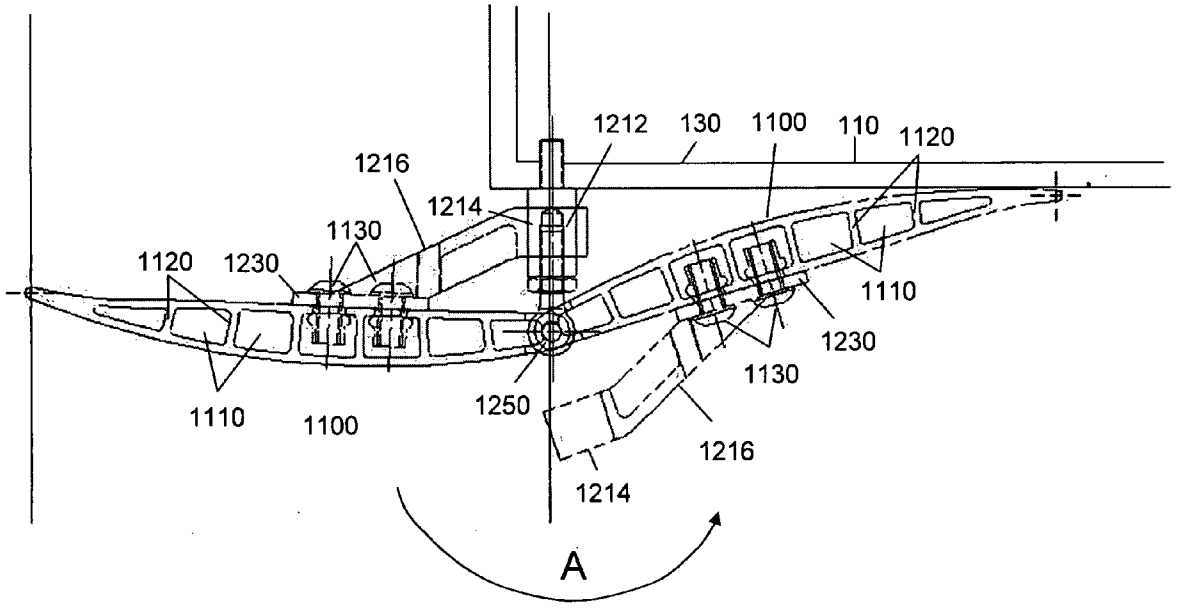
(57) **ABSTRACT**

A drag reduction system [**1000**] is described for large vehicles [**100**] and trailers. The device includes an air deflector [**1100**] which is mounted on a hinged attachment piece [**1200**] near the rear section [**130**] of the vehicle [**100**]. The hinged attachment piece [**1200**] allows the air deflector [**1100**] to extend past a rear section [**130**] of the vehicle [**100**] deflecting an air stream at an angle behind the vehicle [**100**]. The air deflector [**1100**] is allowed to pivot such that it does not extend past the rear section [**130**] of the vehicle [**100**] allowing the vehicle to back up to a loading dock. A second embodiment includes a leading arm [**1500**] and a trailing arm [**1600**] pivotally connected to the air deflector. The air deflector [**1100**] is allowed to translate forward and out of the way allowing the vehicle [**100**] to mate with a standard loading dock.



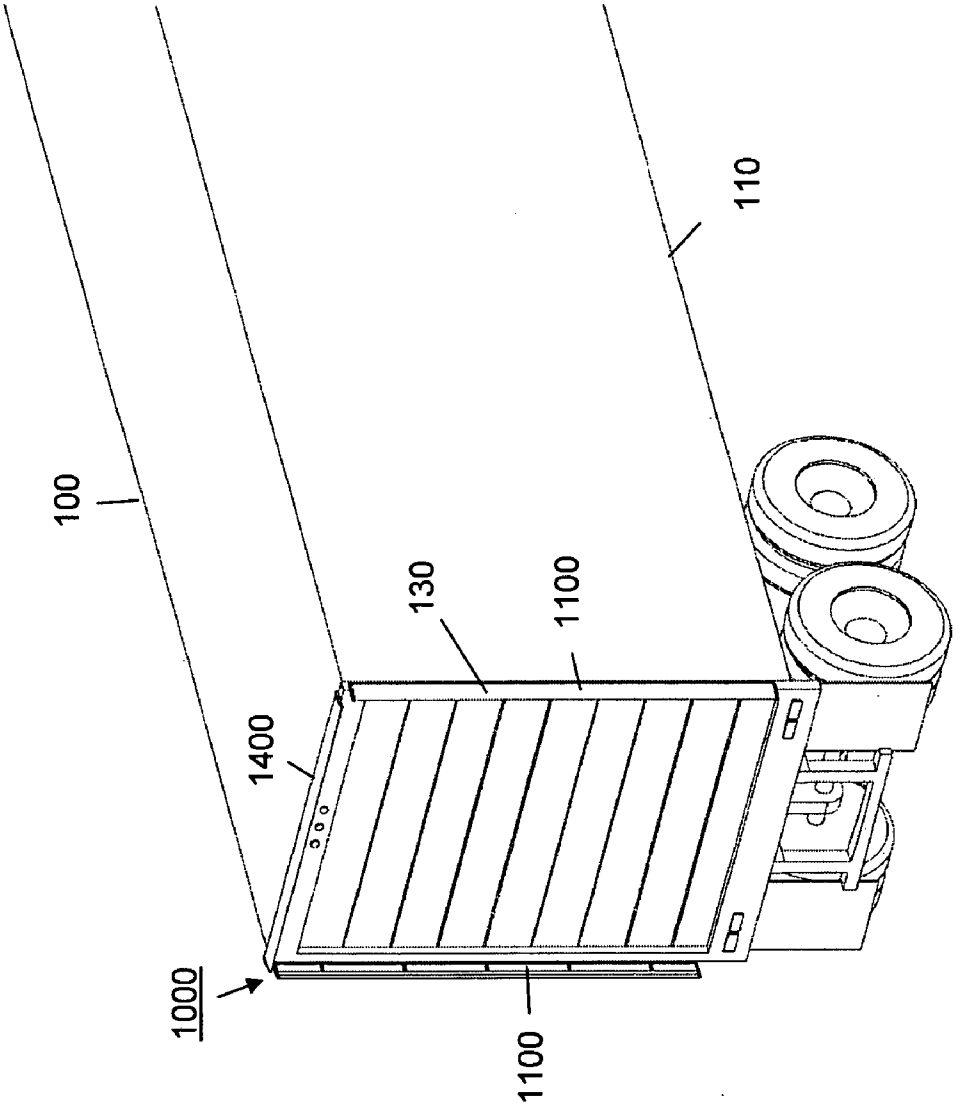


FIG. 1

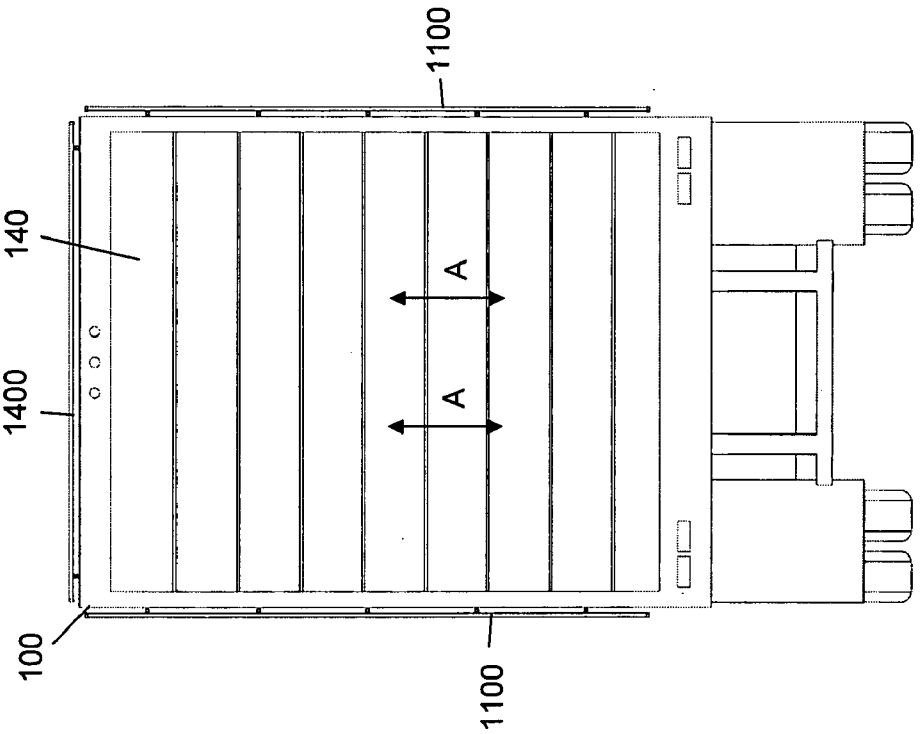


FIG. 2

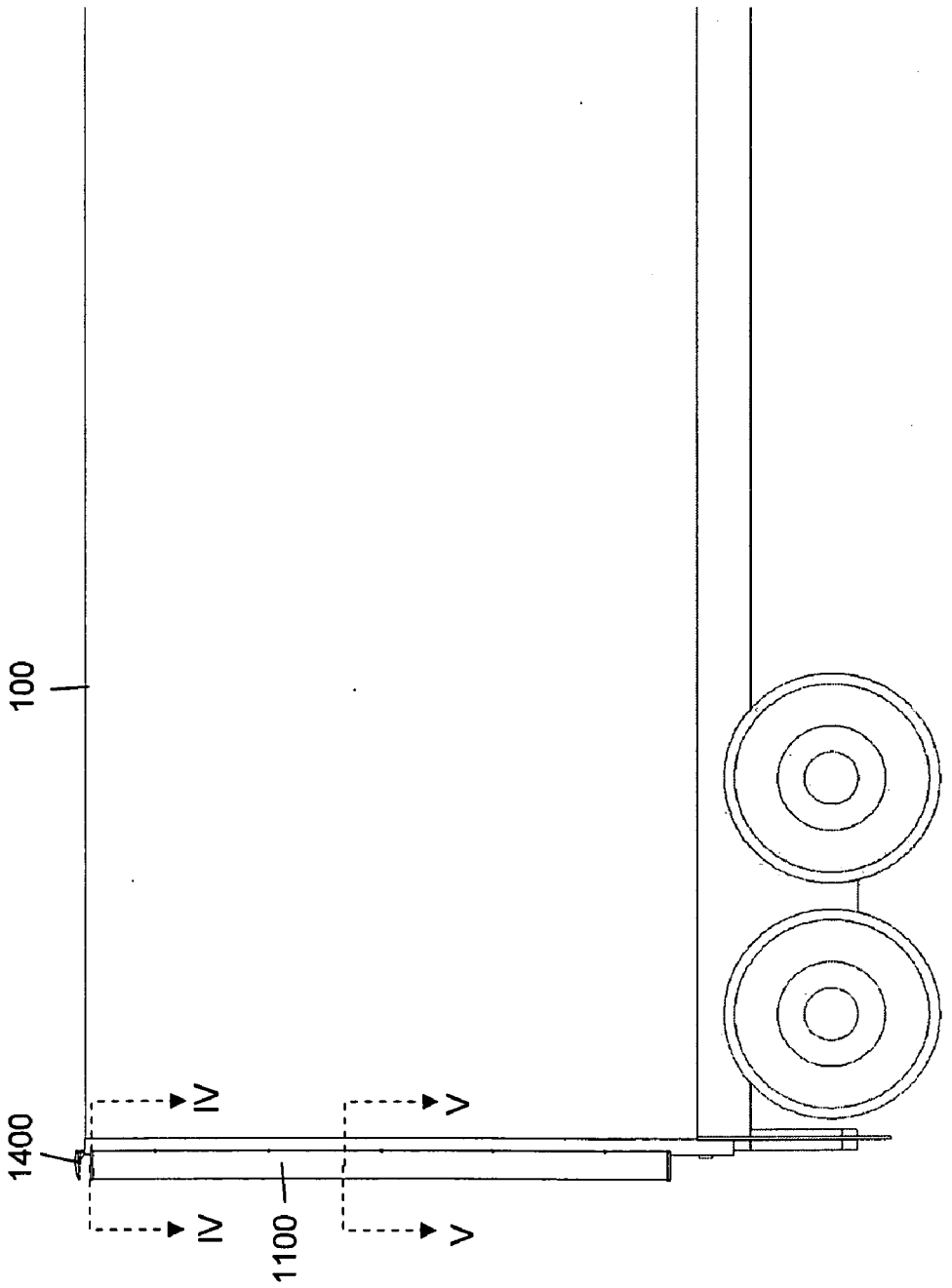


FIG. 3

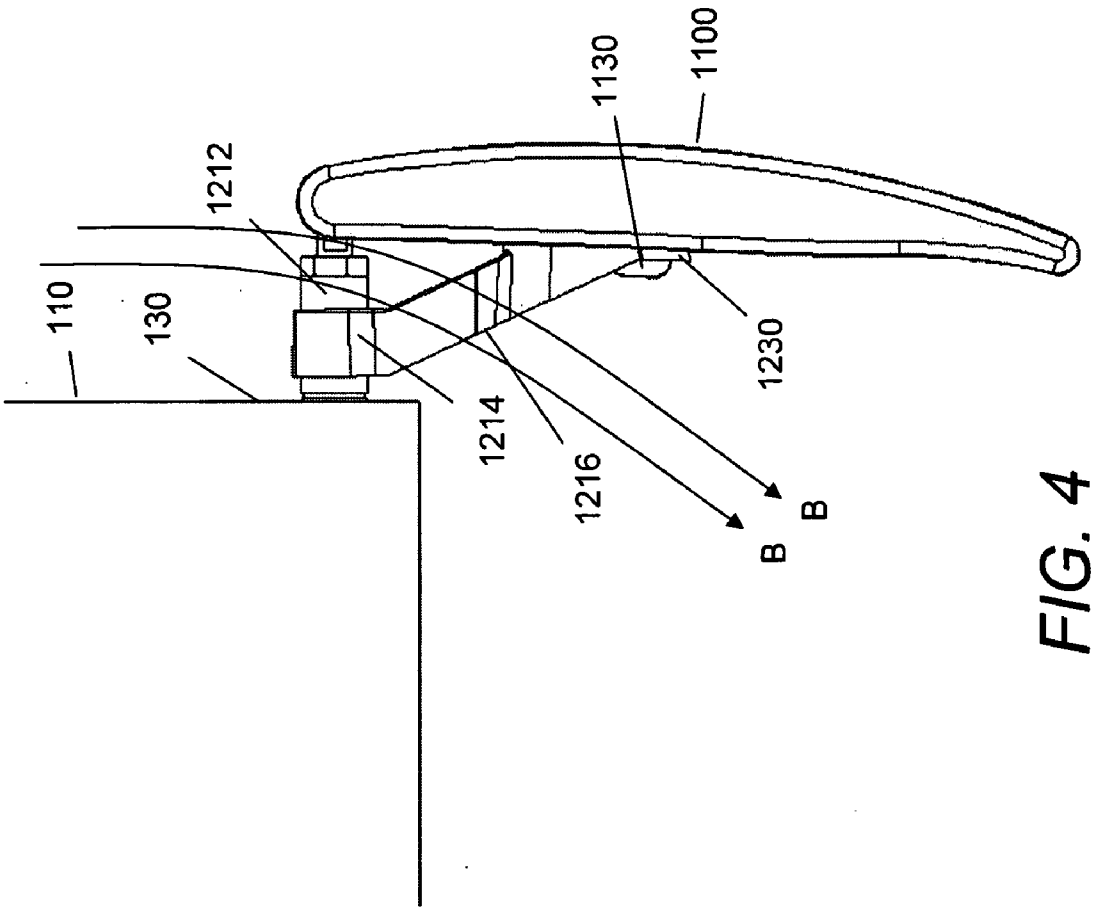


FIG. 4

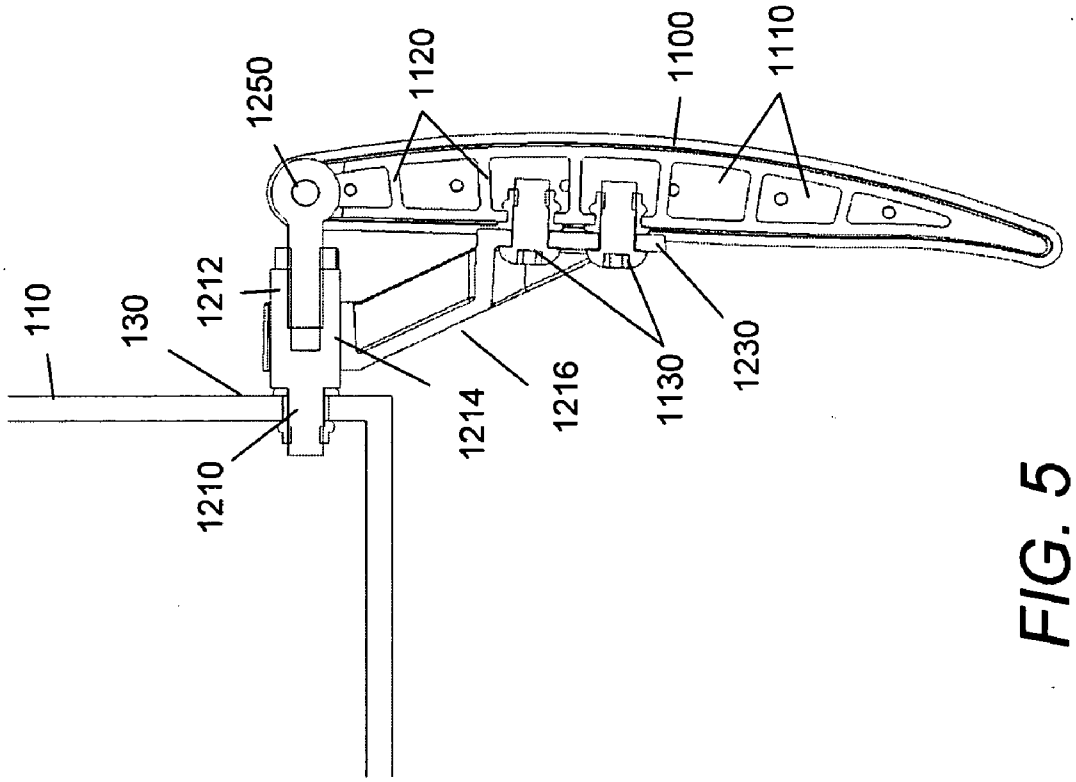


FIG. 5

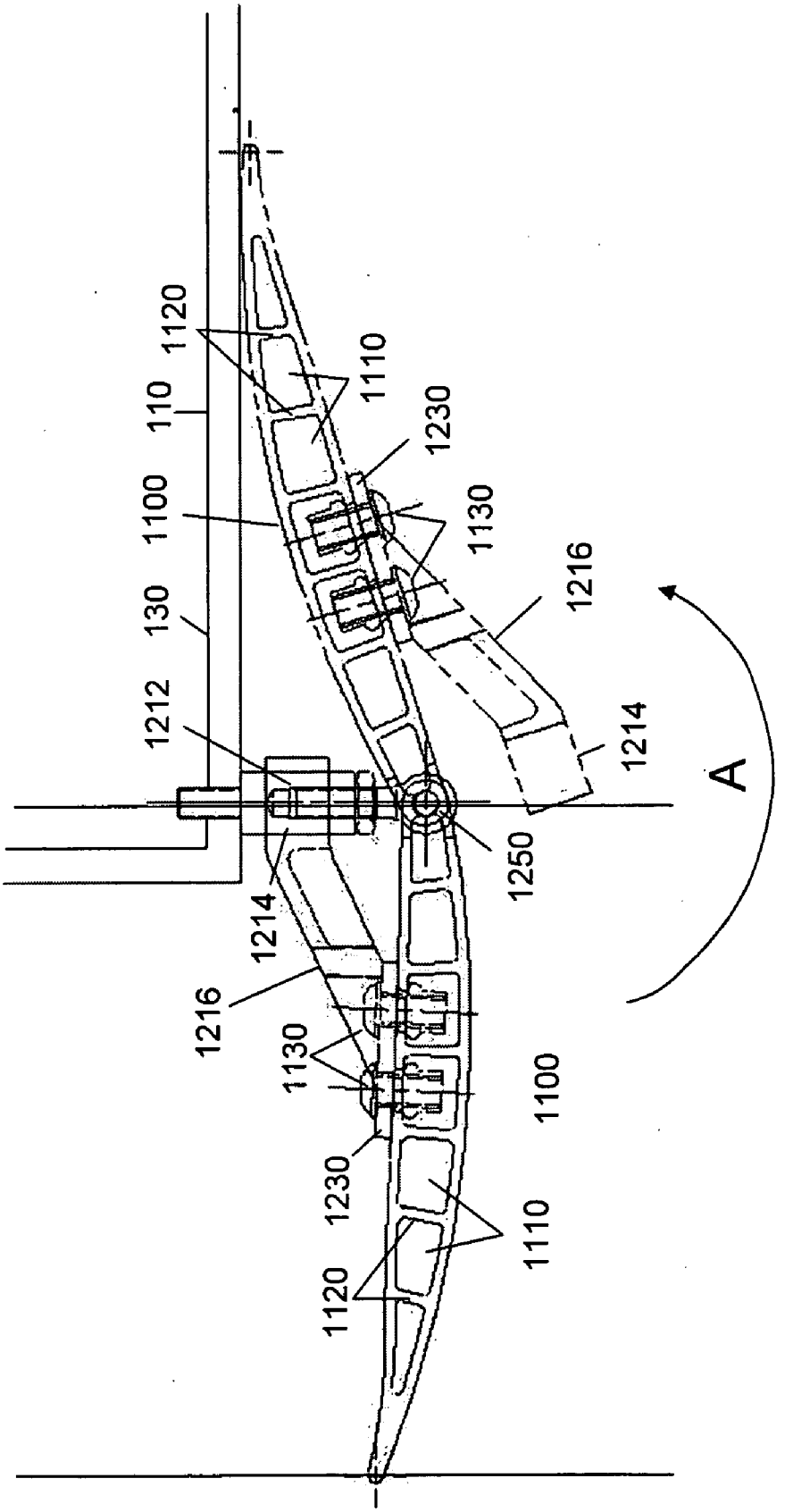

1120
1110
110
1230
1100
1130
130
1216
1212
1214
A
1250
1214
1216
1130
1100
1230
1110
1120

FIG. 6

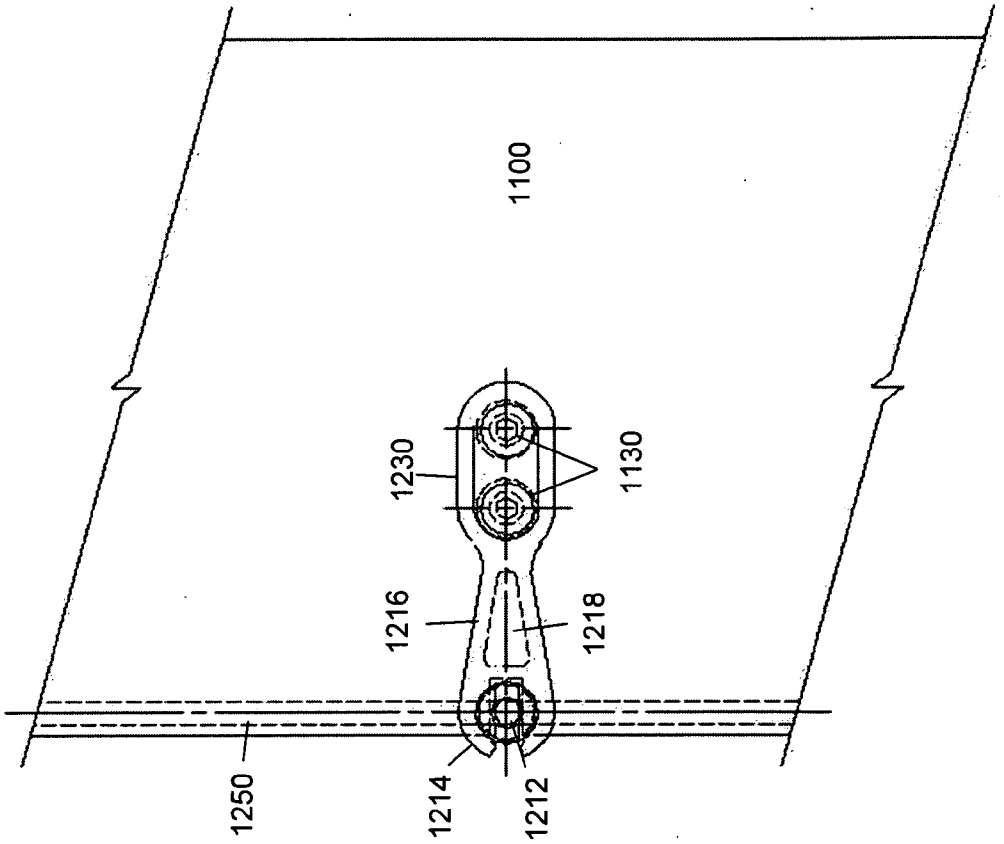


FIG. 7

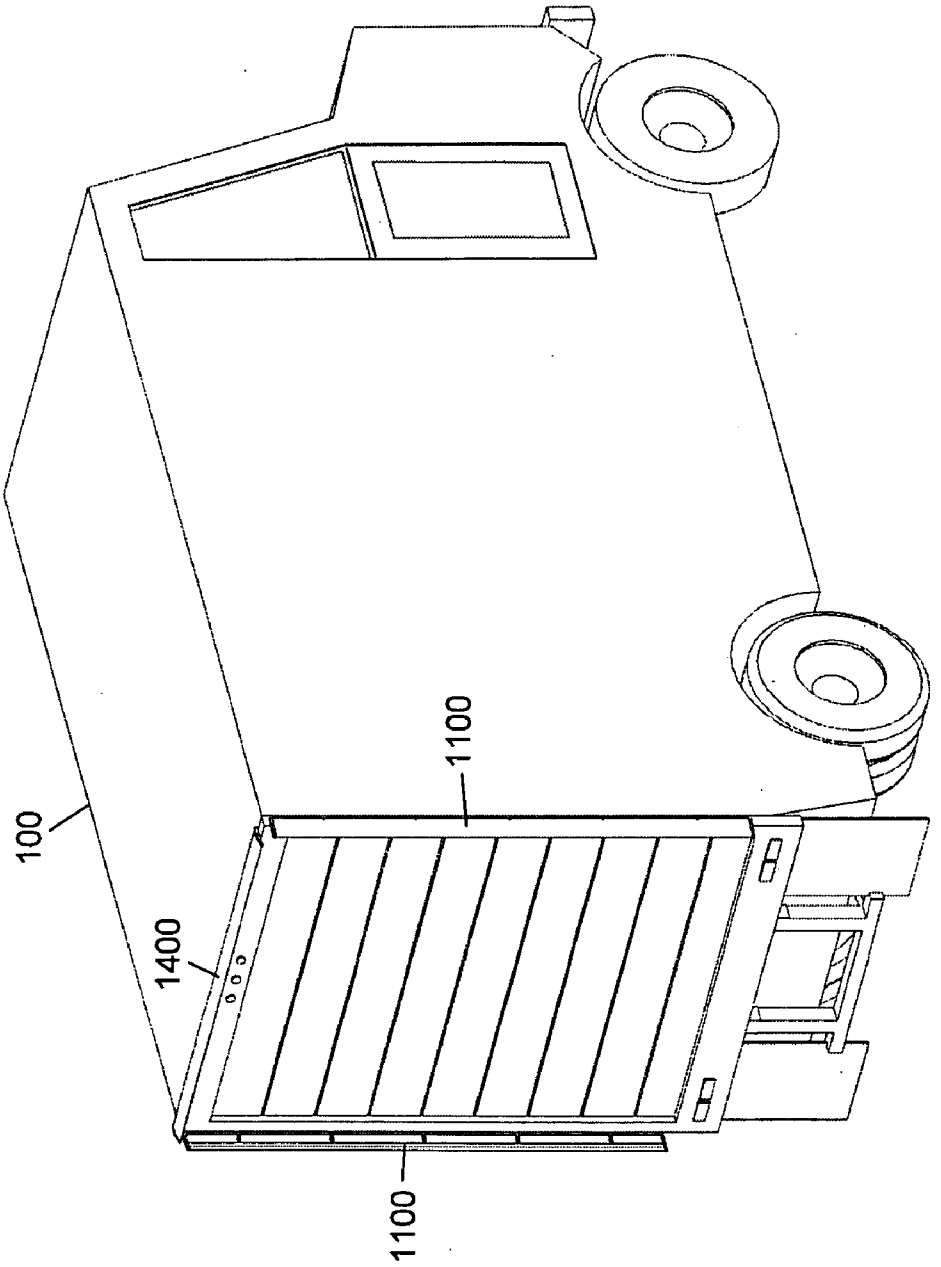


FIG. 8

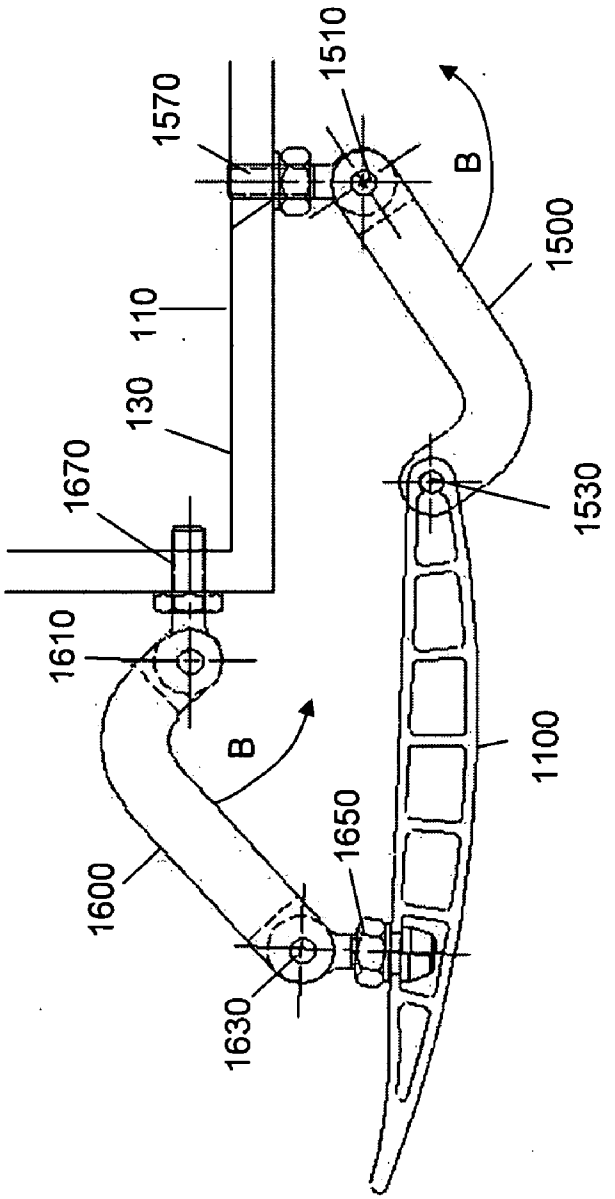


FIG. 9

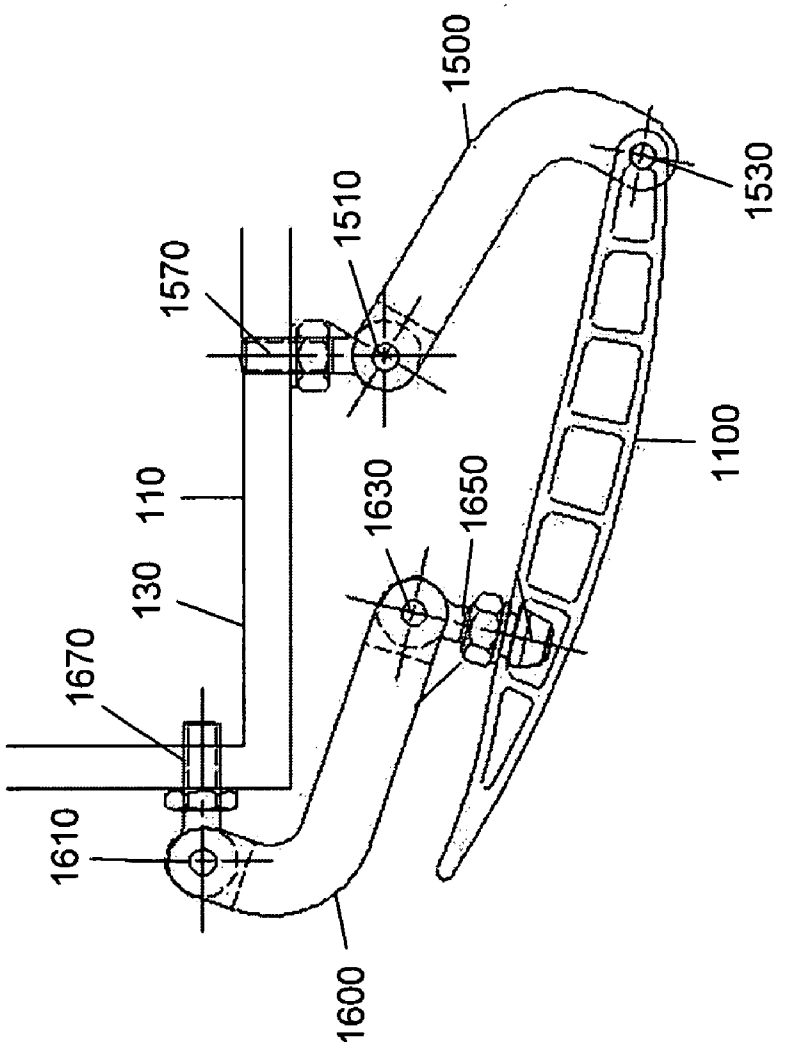


FIG. 10

AIR DRAG REDUCTION SYSTEM

FEDERAL SPONSORED RESEARCH

[0001] Not applicable.

SEQUENCE LISTING OR PROGRAM

[0002] Not applicable.

CROSS REFERENCE TO RELATED APPLICATIONS

[0003] Not applicable.

BACKGROUND OF THE INVENTION

[0004] 1. Field of the Invention

[0005] The present invention relates to a system for reducing air drag on vehicles and more specifically a device that reduces air drag on vehicles leading to improved fuel economy.

[0006] 2. Discussion of Related Art

[0007] As energy costs rise, it is important to increase fuel economy of land vehicles. The problem becomes most acute with larger vehicles, such as busses, recreational vehicles and trucks. If one were to increase the fuel economy of these vehicles, there would be a large cost savings and benefit. If wasted energy can be eliminated, the fuel economy will rise.

[0008] One source of wasted energy is a partial vacuum created behind trucks. Wind passing along the side of a moving truck passes around the back side of the truck. The area just behind the truck experiences a partial vacuum. If one were to reduce this vacuum, fuel economy will increase.

[0009] There have been attempts to reduce this vacuum with the aid of vane connected to the vehicle with several pliant attachment means as described in U.S. Pat. No. 7,240,958 B2 Skopic issued Jul. 10, 2007. Since the trucks are designed to back up to a loading dock and fit flush against a docking seal, there can be no equipment extending past the rear edge of the truck interfering with the seal. This is why the Skopic device is attached to the doors. The Skopic device is designed to be used on trucks having two rear doors which open from the center. These are called "barn-type doors". As the barn-type doors open, they swing outward and forward parallel to the sides of the truck. In doing so, they fold the vane and pliant attachment means between the barn doors and the sides of the truck.

[0010] Due to their design, these cannot fold up out of the way with other types of doors, such as roll-up doors, or other doors besides barn-type doors. The flexible attachment means also becomes awkward and difficult to use.

[0011] Currently, there is a need for a drag reduction device which allows use on loading docks and is compatible with door styles other than barn-type doors.

SUMMARY OF THE INVENTION

[0012] One embodiment of the present invention is a drag reduction system [**1000**] for increasing the fuel efficiency of a vehicle [**100**] having a rear section [**130**], at least one generally planar surface [**110**], and an air stream passing along the rear section [**130**], comprising:

[0013] a) an air deflector [**1100**] at least partially extending past said rear section [**130**] of said vehicle [**100**] for deflecting said air stream at an angle behind said vehicle [**100**],

[0014] b) a hinged attachment piece [**1200**] connected to said vehicle [**100**] and to said air deflector [**1100**] allowing the air deflector to pivot to a first position extending past said rear section [**130**] of said vehicle [**100**] in which it deflects said air stream behind the vehicle [**100**], and a second position in which the air deflector [**1100**] and hinged attachment piece [**1200**] pivot forward and do not extend beyond an end of said rear section [**130**] of said vehicle [**100**] allowing said vehicle [**100**] to fit against a standard loading dock.

[0015] The present invention may also be embodied as a method of reducing air drag and increasing fuel economy of a moving vehicle [**100**] having a rear section [**130**] which is compatible with existing loading docks, comprising the steps of:

[0016] a) pivotally securing an air deflector [**1100**] to extend from the rear of said vehicle [**100**] in a first position angled to direct said air stream to a location behind said vehicle [**100**] when said vehicle is being driven; and

[0017] b) pivoting the air deflectors [**1100**] to a second position so that they do not extend beyond the rear section [**130**] of said vehicle [**100**] when being docked to allow said vehicle rear section [**130**] to mate with a conventional loading dock.

OBJECTS OF THE INVENTION

[0018] It is an object of the present invention to provide a device which reduces wind drag which retrofits existing vehicles increasing fuel economy.

[0019] It is another object of the present invention to provide a device which reduces wind drag which retrofits existing vehicles having roll-up rear doors increasing fuel economy.

[0020] It is an object of the present invention to provide a device which reduces wind drag for vehicles increasing fuel economy.

[0021] It is another object of the present invention to provide a device which reduces wind drag for new vehicles having roll-up rear doors increasing fuel economy.

[0022] It is another object of the present invention to provide a device which reduces wind drag that fold back to allow mating of the vehicle with an existing loading dock.

[0023] It is another object of the present invention to provide a drag reduction system which is compatible with loading docks.

[0024] It is another object of the present invention to provide a method of reducing wind drag for vehicles with roll-up doors while still allowing the vehicle to use existing loading docks.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The advantages of the instant disclosure will become more apparent when read with the specification and the drawings, wherein:

[0026] FIG. **1** is a perspective view of one embodiment of the drag reduction system **1000** according to the present invention as it would appear installed on a truck trailer **100**.

[0027] FIG. **2** is a rear elevational view of the drag reduction system **1000** of FIG. **1**.

[0028] FIG. **3** is a side elevational view of the drag reduction system **1000** of FIGS. **1** and **2**.

[0029] FIG. **4** is an enlarged partial top view along lines "IV"-"IV" of the rear section **130** of the truck trailer **100**.

[0030] FIG. **5** is an enlarged cross sectional view through lines "V"-"V" of FIG. **3** of the rear section **130** of the truck trailer.

[0031] FIG. **6** is an enlarged cross sectional view of a portion of the present invention **1000** attached to the rear section **130** showing both the working and the unloading positions of the present invention.

[0032] FIG. **7** is a partial elevational view from between the vehicle and air deflector showing the flexible snap clip according to the present invention.

[0033] FIG. **8** is a partial perspective view of one embodiment of the drag reduction system **1000** according to the present invention as it would appear installed on a delivery truck **100**.

[0034] FIG. **9** is an enlarged cross sectional view of an alternative embodiment of the present invention in its driving position.

[0035] FIG. **10** is an enlarged cross sectional view of an alternative embodiment of the present invention in its unloading position.

DETAILED DESCRIPTION OF THE INVENTION

[0036] Since vehicles, such as trailer trucks, busses, and recreational vehicles, are very large and not very streamlined, they create significant air drag.

[0037] These vehicles typically have flat rear sections. As they move at highway speeds, turbulence forms behind the vehicles causing a partial vacuum. This partial vacuum creates drag on the vehicle reducing gas mileage.

[0038] Since they are typically driven many miles each year, a small increase in fuel mileage results in a significant cost savings.

[0039] FIG. **1** is a partial perspective view of one embodiment of the drag reduction system **1000** according to the present invention as it would appear installed on a truck trailer **100**.

[0040] Air deflectors **1100** here are attached to the sides **110** of the trailer **100** near the rear section **130**.

[0041] These air deflectors **1100** angle air streams passing along the sides **110** of trailer **100** toward a midline of the trailer **100** behind the trailer **100**. This reduces the partial vacuum behind the vehicle and increases fuel economy.

[0042] To become more efficient, they would have to extend past the rear of vehicle **100**. Trailers **100** are typically backed up to loading docks for loading/unloading. The rear section **130** is pressed against padding on the loading dock to create an air seal between the trailer **100** and the loading dock. This allows the trailer to be loaded/unloaded from a loading dock which is shielded from the weather. Therefore, there should be no obstructions extending from the rear of the trailer **100** to interfere with the mating of the truck rear section **130** with the loading dock seal.

[0043] Depending upon the shape of the trailer, it may also be beneficial to add top deflector **1400** on the top surface near the rear of trailer **100**.

[0044] FIG. **2** is a rear elevational view of the drag reduction system **1000** of FIG. **1**. Please note that the drag reduction system **1000** is attached to the vehicle **100** and not the doors or gates as in prior art designs. The type shown in FIGS. **1**, **2**, **3**, and **8** are roll-up doors **140** which roll up or down in the direction of the arrows marked "A".

[0045] The doors on other trailers are typically barn-type doors. These are dual doors which meet at the center and open outward and swing to fit flush against the sides **110** of the trailer. The prior art air deflection systems, such as that of Skopic, rely upon this geometry to fold the air deflection apparatus away from the rear of the trailers. These types of air deflection systems would not function, or not function well, with these roll-up type doors shown in the figures.

[0046] As is obvious here, the present invention does not rely upon barn-doors to fold it back and out of the way. The present invention is designed to attach to a fixed portion of the vehicle, and is designed to fold by itself.

[0047] FIG. **3** is a side elevational view of the drag reduction system **1000** of FIGS. **1** and **2**. Here it can be seen how air deflectors **1100** extend past the rear of trailer **100**.

[0048] FIG. **4** is an enlarged partial top view along lines "IV"-"IV" of the rear section **130** of the truck trailer **100**. One side of the drag reduction system **1000** is shown here.

[0049] A plurality of anchor pieces **1212** attach to the rear section **130** of vehicle **100** along the side **110**.

[0050] The top section of anchor pieces **1212** employ a hinge (not shown in this view) allowing air deflector **1100** to pivot with respect to the anchor piece **1212** and side **110**.

[0051] An angled arm **1216** has a deflector mount **1230** which attaches to the air deflector **1100**.

[0052] Angled arm **1216** has a flexible snap clip **1214** which is designed to snap on and off of anchor piece **1212**. When snapped onto anchor piece **1212**, air deflector **1100** is held in the position shown here. This is the working position. Here it can be seen that air streams are diverted following the path according to arrows marked "B".

[0053] FIG. **5** is an enlarged cross sectional view of the drag reduction system **1000** through lines "V"-"V" of FIG. **3** of the rear section **130** of the truck trailer **100**.

[0054] In this embodiment, anchor piece **1212** is shown having a vehicle mount **1210** which passes through side **110** of vehicle **100** to secure it to side **110**.

[0055] Anchor piece **1212** has a hinge piece **1250** which connects air deflector **1100** to anchor piece **1212**.

[0056] In this position, flexible snap clip **1214** of the angled arm **1216** attaches to anchor piece **1212** holding air deflector in this position.

[0057] Deflector mount **1230** of angled arm **1216** is shown here attached to air deflector **1100** with fasteners **1130**.

[0058] In alternative embodiments of the present invention, angled arm **1216** may be attached to air deflector **1100** by any other known means of attachment.

[0059] In order to keep the air deflector **1100** light, yet strong, it is designed to have hollow spaces **1110** with intermediate ribs **1120**.

[0060] FIG. **6** is an enlarged cross sectional view of a portion of the present invention **1000** attached to the rear section **130** showing both the working and the unloading positions of the present invention.

[0061] All of the parts having the same number as the previous figure have the same function as described with reference to the previous figures.

[0062] The air deflector **1100** is shown in phantom pivoted around hinge **1250** into its unloading position. It is placed in this position prior to backing up the trailer **100** to the loading dock.

[0063] As is visible, flexible snap clip **1214** is pulled off of anchor piece **1212** allowing the entire structure to rotate in the direction marked "A".

[0064] Angled arm **1216** remains fixed to air deflector **1100** with fasteners **1130** that attach the deflector mount **1230** to air deflector **1100**.

[0065] The entire assembly pivots around hinge **1250** and out of the way allowing the vehicle to back up to and meet flush with the loading dock surface.

[0066] FIG. **7** is a partial elevational view from between the vehicle **100** and air deflector **1100** showing the flexible snap clip **1214** according to the present invention.

[0067] This is an enlarged image showing flexible snap clip **1214** attached to anchor piece **1212**. Angled arm **1216** is shown with a hollowed section **1218** to reduce weight.

[0068] The deflector mount **1230** is shown here attached to air deflector **1100** with two fasteners **1130**.

[0069] The entire structure, except the anchor piece **1212**, is allowed to rotate about hinge **1250** when flexible snap clip **1214** is not attached to anchor piece **1212**.

[0070] Other removable attachment means may also be used in place of anchor piece **1212** and flexible snap clip **1214** for holding air deflector **1100** in the working position when connected but allow the air deflector to pivot into the unloading position when not attached.

[0071] Such means may be any conventional mechanical removable attachment means including latches, locks, clips, snaps, connectors, and fittings. Other non-mechanical means may be used such as magnets, hook and loop, two-part material (similar to the connectors sold under the trademark Velcro®)), or other known fasteners.

[0072] FIG. **8** is a partial perspective view of one embodiment of the drag reduction system **1000** according to the present invention as it would appear installed on a delivery truck **100**.

[0073] In this alternative embodiment, the delivery truck does not have the barn-type doors on the rear.

[0074] A pair of air deflectors **1100** is attached on the sides **110** near the rear section **130**.

[0075] As stated above, alternatively, a top deflector **1400** may be used.

[0076] Even though the present invention was described in connection with the side air deflectors **1100**, they apply equally well to the top deflector **1400**.

[0077] The present invention **1000** may also be employed in an embodiment which connects to the fixed portion of the rear of the vehicle **100**. This may be the structure on the sides of a roll-up door or other fixed structure.

[0078] FIG. **9** is an enlarged cross sectional view of an alternative embodiment of the present invention in its driving position.

[0079] Here the air deflector **1100** is pivotally attached to the sides **110** of the rear section **130** of the vehicle. It employs a leading arm **1500** and a trailing arm **1600**. A leading arm vehicle mount **1570** is attached to a side **110** of the vehicle. A first end of the leading arm **1500** is pivotally attached to the leading arm vehicle mount **1570** through a leading arm vehicle hinge **1510**.

[0080] A second end of the leading arm **1500** is pivotally attached to the air deflector **1100** at a leading arm deflector hinge **1530**.

[0081] Similarly, a trailing arm **1600** has a first end pivotally attached to a deflector mount **1650** through a trailing arm deflector hinge **1630**. The deflector mount **1650** is attached to the air deflector **1100**.

[0082] In FIGS. **9** and **10** the trailing arm vehicle mount **1670** is shown attached to the rear of the vehicle. However, in alternative embodiments, it may be attached to the sides **110**.

[0083] A second end of the trailing arm **1600** is pivotally attached to the trailing arm vehicle mount **1670** through a trailing arm vehicle hinge **1610**.

[0084] The leading arm **1500** and the trailing arm **1600** act to hold air deflector **1100** in driving position which extends past the rear of the vehicle and is angled to cause air to be deflected to a location behind the vehicle. The air deflector **1100** leading arm **1500**, trailing arm **1600** and attached parts are intended to remain in this position as the vehicle is being driven. This deflects the air to a location behind the vehicle reducing air drag and increasing fuel economy.

[0085] The leading arm **1500**, the trailing arm **1600** and air deflector **1100** are designed to pivot in the direction marked by the arrow marked "B" to move it to the unloading position.

[0086] FIG. **10** is an enlarged cross sectional view of an alternative embodiment of the present invention in its unloading position.

[0087] Here is shown that air deflector **1100** has translated forward to allow the rear section **130** of the vehicle to back up to a loading dock unhindered.

[0088] In this embodiment, trailing arm vehicle hinge **1610** extends slightly past the end of the vehicle. Since the perimeter of standard loading docks includes flexible seals that deform slightly, the present invention may be used with these loading docks.

[0089] In an alternative embodiment, the trailing arm vehicle mount **1670** is attached to the side **110** of the vehicle instead of its rear surface. The length of the trailing arm **1600** may be changed to compensate for the different mounting position. This embodiment also may be used and translated forward during loading to be compatible with existing loading docks.

[0090] Also, the present invention is applicable to other large vehicles that do not employ barn-type rear doors.

[0091] Since other modifications and changes varied to fit particular operating requirements and environments will be apparent to those skilled in the art, the invention is not considered limited to the example chosen for the purposes of disclosure, and covers all changes and modifications which do not constitute departures from the true spirit and scope of this invention.

What is claimed is:

1. An air drag reduction system [**1000**] for increasing the fuel efficiency of a vehicle [**100**] having a rear section [**130**] at least one generally planar, side, surface [**110**] and an air stream passing along the rear surface [**130**], comprising:

a) an air deflector [**1100**] at least partially extending past said rear section [**130**] of said vehicle [**100**] for deflecting said air stream at an angle behind said vehicle [**100**],

b) a hinged attachment piece [**1200**] connected to said vehicle [**100**] and to said air deflector [**1100**] allowing the air deflector to pivot to a first position extending past said rear section [**130**] of said vehicle [**100**] in which it deflects said air stream behind the vehicle [**100**], and a second position in which the air deflector [**1200**] and hinged attachment piece [**1200**] pivot forward and do not extend beyond an end of said rear section [**130**] of said vehicle [**100**] allowing said vehicle [**100**] to fit against a standard loading dock.

2. The air drag reduction system [**1000**] of claim **1**, wherein the air deflector [**1100**] is elongated, extending a major portion of said vehicle's [**100**] height.

3. The air drag reduction system [**1000**] of claim **1**, wherein the hinged attachment piece [**1200**] comprises:

a) a vehicle mount [**1210**] which attaches to said vehicle [**100**];

b) a deflector mount [**1230**] which is connected to the air deflector [**1100**]; and

c) a hinge [**1250**] which pivotally connects the vehicle mount [**1210**] to the deflector mount [**1230**], allowing the deflector mount [**1230**] to be placed in the first position or the second position.

4. The air drag reduction system [**1000**] of claim **3**, wherein the hinged attachment piece [**1200**] further comprises:

a) a first connector [**1211**] which is attached to the vehicle mount [**1210**];

b) a second connector [**1231**] attached to the deflector mount [**1230**] adapted to be removeably attached to the first connector [**1211**] to hold the deflector mount [**1230**] and the air deflector [**1100**] in the first position, thereby deflecting said air stream at an angle behind the vehicle [**100**].

5. The drag reduction system [**1000**] of claim **1**, wherein the first and second connectors [**1211**. **1231**] comprise:

a) an anchor piece [**1212**]; and

b) a flexible snap clip [**1214**] which removeably attaches to said anchor piece.

6. The air drag reduction system [**1000**] of claim **1**, wherein the first and second connectors comprise:

hook and loop attachment material.

7. The air drag reduction system [**1000**] of claim **1**, wherein the first and second connectors comprise: snaps.

8. The air drag reduction system [**1000**] of claim **3** wherein the vehicle mount [**1210**] is designed to retrofit existing vehicles [**100**].

9. The drag reduction system [**1000**] of claim **3** wherein the vehicle mount [**1210**] is designed to be a part of a newly manufactured vehicle [**100**].

10. The air drag reduction system [**1000**] of claim **3** wherein the deflector mount [**1230**] is manufactured as part of the air deflector [**1100**].

11. A method of reducing air drag and increasing fuel economy of a moving vehicle [**100**] having a rear section [**130**] which is compatible with existing loading docks, comprising the steps of:

a) pivotally securing an air deflector [**1100**] to extend from the rear of said vehicle [**100**] in a first position angled to direct said air stream to a location behind said vehicle [**100**] when said vehicle is being driven; and

b) pivoting the air deflectors [**1100**] to a second position so that they do not extend beyond the rear section [**130**] of said vehicle [**100**] when being docked to allow said vehicle rear section [**130**] to mate with a conventional loading dock.

12. The method of claim **11** further comprising the step of employing a first connector [**1211**] to connect to a second connector [**1231**] to hold the air deflector [**1100**] in its first position.

13. The method of claim **12** further comprising the step of disconnecting first connector [**1211**] from the second connector [**1231**] to allow the air deflector [**1100**] to pivot so that it does not extend beyond said rear section [**130**].

14. The method of claim **12** wherein the step of employing a first connector [**1211**] and a second connector [**1231**] comprises the step of:

employing an anchor piece [**1212**] as the first connector [**1211**] and a flexible snap clip [**1214**] which removeably attaches to said anchor piece [**1212**] as the second connector [**1231**] to hold the air deflector [**1100**] in its first position.

15. The method of claim **12** wherein the step of employing a first connector [**1211**] and a second connector [**1231**] comprises the step of:

employing a first hook and loop attachment material as the first connector [**1211**] and a second hook and loop attachment material which is capable of removeably attaching to the first hook and loop material as the second connector [**1231**] which attach to each other to hold the air deflector [**1100**] in its first position.

16. The method of claim **12** wherein the step of employing a first connector [**1211**] and a second connector [**1231**] comprises the step of:

employing a first snap part as the first connector [**1211**] and a second snap part which is adapted to removeably attach to the first snap part as the second connector [**1231**] which attach to each other to hold the air deflector [**1100**] in its first position.

17. An air drag reduction system [**1000**] for increasing the fuel efficiency of a vehicle [**100**] having a rear section [**130**] at least one generally planar, side, surface [**110**] and an air stream passing along the rear surface [**130**], comprising:

a) an air deflector [**1100**] having a leading edge and a trailing edge, at least partially extending past said rear section [**130**] of said vehicle [**100**] for deflecting said air stream at an angle behind said vehicle [**100**];

b) a leading arm [**1500**] having a first end pivotally connected to said vehicle [**100**] and a second end pivotally connected to the leading edge of the air deflector [**1100**]; and

c) a trailing arm [**1600**] having a first end pivotally connected to said vehicle [**100**] and a second end pivotally connected to the trailing edge of the air deflector [**1100**].

18. The air drag reduction system [**1000**] of claim **17**, further comprising a leading arm vehicle hinge [**1510**] to pivotally connect the leading arm [**1500**] to the vehicle [**100**];

19. The air drag reduction system [**1000**] of claim **17**, further comprising a leading arm deflector hinge [**1530**] to pivotally connect the leading arm [**1500**] to the air deflector [**1100**].

20. The air drag reduction system [**1000**] of claim **17**, further comprising a trailing arm vehicle hinge [**1610**] to pivotally connect the trailing arm [**1600**] to the vehicle [**100**];

21. The air drag reduction system [**1000**] of claim **17**, further comprising a trailing arm deflector hinge [**1630**] to pivotally connect the trailing arm [**1600**] to the air deflector [**1100**].

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